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(54) SCRIM REINFORCED PAPER/PLASTIC BOARDS

(72) Sidorenko, Victor and Millington, Alan D., Canada

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This invention relates in general to certain new and useful improvements in corrugated paper/plastic board materials, and more particularly, to corrugated paperboard material which is reinforced by a scrim reinforcement in the form of rows of intersecting strands.

Corrugated paperboard materials have found widespread use in many commercial and industrial applications, such as in the manufacture of shipping cartons, storage boxes and other forms of containers which find a wide variety of uses. In addition, corrugated paperboard materials have recently been used in several structural applications, and basically in many areas which were otherwise previously served by more rigid materials such as plastic or metal sheets or the like.

However, in order to increase the applications in which corrugated paperboard materials may be used, the manufacturers of these materials have found that it has been necessary to reinforce these paperboard materials in order to effectively lend the materials to these other applications. The extant techniques presently used in the reinforcement of paperboard materials have generally relied upon the employment of additional or thicker layers used in the making of the paperboard sheet. However, these techniques for reinforcing the paperboard material have not been too effective, and have substantially added to the overall cost of manufacturing the paperboard material.

The present invention overcomes these and other problems in the provision of a reinforcing scrim to one or more surfaces of a paperboard material. The scrim is uniquely designed to provide an optimum amount of reinforcement without materially changing present methods of manufacture of the corrugated board and also aids in increasing the esthetic

appearance of the paperboard materials.

In one aspect of the invention there is provided a corrugated paperboard type material having improved puncture resistance having a reinforcing scrim bonded to at least one surface thereof, said reinforcing scrim comprising a plurality of rows of intersecting strands of a thermoplastic polymeric material.

In another aspect of the invention there is provided an improved corrugated paperboard material having high puncture resistance comprising a plurality of alternating layers of liner material and corrugated material bonded thereto, the exterior surfaces of said paperboard material being formed of a liner layer, and at least one of said exterior surfaces having a reinforcing scrim bonded thereto, said reinforcing scrim comprising a plurality of rows of spaced apart intersecting strands of a thermoplastic polymeric material, each of said strands being substantially flat and having an ultimate elongation substantially corresponding to that of the paperboard material.

In a further aspect of the invention there is provided in a board material, the improvement wherein said board material has bonded thereto a reinforcing scrim, said reinforcing scrim comprising a plurality of rows of intersecting strands of a thermoplastic polymeric material.

In a still further aspect of the invention there is provided the method of reinforcing a paperboard material to form a product having improved puncture resistance comprising bonding to one flat outer surface of said material a reinforcing scrim comprised of a plurality of rows of intersecting strands of a thermoplastic polymeric material.

In one embodiment, the rows of intersecting strands which form the reinforcing scrim can be characterized in that a plurality of first spaced-apart substantially parallel rows of the strands and a plurality of second spaced-apart substantially parallel rows of the strands form a reinforcing matrix scrim and in which the second rows of strands are substantially perpendicular to the first rows of strands. These reinforcing strands may be woven or non-woven.

The reinforcing scrim, in one aspect of the present invention, may be applied directly to one surface of the corrugated paperboard material. In another aspect of the present invention, the reinforcing strands or the scrim may be applied to one surface of a plastic substrate and which is, in turn, applied to at least one exposed flat surface of the paperboard material. In yet another embodiment of the present invention, these rows of intersecting strands are applied to both opposite exposed flat surfaces of the paperboard material. In like manner, the rows of strands can be applied to one surface of the plastic substrate and this type of substrate is applied to both opposite exposed flat surfaces of the corrugated paperboard material. In yet another aspect of the present invention, the rows of intersecting strands can be applied to both flat surfaces of plastic substrates and these substrates, in turn, applied to both of the exposed flat

surfaces of the paperboard material.

Generally, the rows of intersecting strands which form the reinforcing scrim are adhesively secured to the surface of the paperboard material. Otherwise, the strands may be pre-formed with a plastic substrate and this plastic substrate may be adhesively secured to the surface of the paperboard material or otherwise secured thereto by any of the number of known methods of securing plastic films to paperboard materials.

Generally, the preferred method for making the reinforced corrugated paperboard product is to laminate the reinforcing scrim to at least one of the paper or paperboard layers/sheets (which normally form the structural elements of a conventional corrugated paperboard product) prior to the manufacture of the corrugated product itself. The addition of the scrim to the flat sheet, without the corrugated element being present, is generally a simpler operation than its addition to the paperboard material containing a corrugated element. One such particular reinforced laminate and method of making it is described in Canadian Patent No. 879,070. Once a reinforced paperboard sheet is formed it is then used as at least one of the structural elements in a corrugated paperboard material/product. For example, such a reinforced sheet laminate could be used for the liner and/or corrugated elements. In most applications, its use as one of the liner elements is usually sufficient. Such products can generally be made using conventional corrugating equipment or on such equipment with minor modifications. A more recent method for producing a corrugated product is described in Canadian Patent No. 879,643; the product and method therein described could be of interest to the present invention.

Generally, as described above, the corrugated paper-

board material will comprise a pair of spaced-apart liners with a corrugated element therebetween (commonly referred to as "double-face" corrugated board) and in this case, the reinforcing scrim is attached to the exterior surface of one of the liners. In the application where only one liner is used (commonly called "single face" corrugated board) the reinforcing scrim would be attached to the exterior surface of that one liner. In other products, the scrim could be attached to the interior surface of the liner or liners. Another form of paperboard material which can be used in accordance with the present invention comprises at least two outer liners and an inner liner with corrugated elements between each of the two outer liners and the inner liner, and in this case, the reinforcing scrim could be attached in a number of ways as suggested above; generally it would be either attached to the exterior surface of one of the two said outer liners or placed between the liners. It should be understood that the two paperboard constructions described above are only exemplary of the large number of paperboard materials which can be reinforced in accordance with the present invention. Furthermore, in accordance with this invention, it is possible for the product to include multiple layers of the corrugated material.

In many cases, the reinforcing scrim and/or the plastic substrate and/or the paperboard elements with which it may be formed may have added to it a suitable flame retardant material such as any of a number of known organo-phosphorus compounds or the scrim and/or plastic may itself be fire resistant.

The reinforcing scrim also improves the paperboard material by enhancing its esthetic appearance. In this case, the reinforcing scrim is formed of a network of rows of intersecting strands and the strands or rows are generally arranged

in perpendicular relationship with respect to each other. It should be recognized that the reinforcing scrim and/or the plastic substrate with which it may be formed may be suitably impregnated with a coloring agent or the like to render a colored outer appearance to the paperboard material or it may have a design suitably applied thereto. Thus, in both of the above cases, the reinforcing scrim not only reinforces the paperboard material, but lends to the attractiveness of the material, and in addition adds other desirable properties to the product.

While the reinforcing scrim has been illustrated as being comprised of rows of intersecting strands which are arranged in perpendicular relationship with respect to each other, it should be understood that other geometric forms of reinforcing scrim could be employed. The perpendicular arrangement of the intersecting rows is preferred in most applications due to the increased reinforcing ability and ease of manufactur. However, in many applications, it is quite suitable to employ reinforcing strands which intersect at acute or oblique angles with respect to each other.

When the reinforcing scrim is formed on a plastic substrate or overcovered by a plastic film in the manner as previously described, the plastic used may be chosen from any of a number of known materials, such as polyethylene, polypropylene and several copolymers thereof and several of the polyester and polyvinyl (PVC) materials, etc. These plastic films or substrates may or may not be biaxially oriented. For reasons of cost and ease of adhesion, low density polyethylene is the preferred plastic. , The strand material may be formed of several linear filaments which lend reinforcement to the surface to which they are applied. Thus, for example, each strand may be formed of a plurality of aligned fibers or

filaments and these may be of natural origin such as jute, sisal, asbestos, cotton, or of synthetic origin, e.g. synthetic plastics. One of the preferred strands are those resembling tapes or ribbons, particularly those described in Canadian Patent 879,070. These tapes or ribbons should not be less than .5 mil or the resultant laminate will not have an adequate increase in tensile strength, particularly puncture and tear, over and above that obtainable when no film strips are used. When a thickness of 3 mil is exceeded it has been found that the increases in strength do not warrant the extra expense incurred in using the thicker film.

The width of the tape strip or ribbon should be no less than .1 and no greater than .2 inches wide. This width of tape, coupled with a very specific lateral spacing between the tapes of no less than 0.05 and no greater than .3 inches provides the ultimate product with the required tear strength.

The ultimate elongation of the tapes or ribbons should not exceed 30% and preferably should correspond, in most cases, with that of the paper. Thus, the ribbons should be oriented so that their ultimate elongation is in the range of 5 to 30%; otherwise, the paper or cellulosic material breaks too soon before the tapes.

Having thus described the invention in general terms, reference will now be made to the accompanying drawings which illustrate several practical embodiments of the present invention and in which:

FIGURE 1 is a vertical sectional view showing the interior of the improved paperboard material constructed in accordance with and embodying the present invention;

FIGURE 1a is a top plan view of the improved paperboard material of Figure 1 and being partially broken away to expose several intermediate layers thereof;

FIGURE 2 is a vertical sectional view of a modified form of the improved paperboard material which is constructed in accordance with and embodying the present invention;

FIGURE 2a is a top plan view of the paperboard material of Figure 2, partially broken away to expose several of the intermediate layers thereof;

FIGURE 3 is a vertical sectional view of another modified form of improved paperboard material constructed in accordance with and embodying the present invention;

FIGURE 3a is a top plan view of the improved paperboard material of Figure 3 and partially broken away in order to expose several of the intermediate layers thereof;

FIGURE 4 is a partial perspective view, broken away and in section, and showing an application of the reinforcing scrim to a plastic substrate which may be applied to the improved paperboard material of the present invention; and

FIGURE 5 is a vertical sectional view of yet another modified form of improved paperboard material in accordance with the present invention.

Referring now in more detail and by reference characters to the drawings which illustrate several practical embodiments of the present invention, A designates an improved paperboard material which generally comprises a pair of spaced-apart opposed outer layers 10 and 12 or so-called "liners" which are separated by and connected to an intermediate fluted or corrugated layer 14. Applied to the upper and outwardly presented flat surface of the liner 10 is a reinforcing scrim 16 which is comprised of rows of intersecting strands of material, in the manner as illustrated in Figures 1 and 1a. This reinforcing scrim matrix may be adhesively applied to the

upper surface of the layer 10 or it may be applied in any of a number of other fashions. Several known adhesive materials may be employed for this purpose.

As previously described, in one method embodiment the scrim matrix 16 is attached (e.g. laminated) to liner 10, using conventional techniques, and the scrim reinforced liner 16, 10 and liner 12 are then attached to corrugated layer 14 in a separate operation using conventional techniques for manufacturing corrugated paperboard. A preferred method of attaching scrim 16 to liner 10 is to coat the surface of liner 10 with a film of low density polyethylene (PE) film using an extruder; and while the film is still relatively fluid, embed/lay scrim 16 in the film of PE; on cooling, the PE film not only serves to attach scrim 16 to liner 10 but also serves as further reinforcement as well as a barrier to liquids, gases, puncture, etc. The thickness of PE film will depend on the properties desired, however, in many instances a film of approximately 0.5 mil thick has been found to be effective. The liners generally consist of kraft linerboard having a basis weight of approximately 42 lbs. per 1000 square feet; the corrugated layer generally consists of kraft linerboard or semi-chemical medium with a 26 lb. per 1000 square feet basis weight. While the scrim can be made from a large variety of materials, the preferred type of scrim is that described in Canadian Patent No. 879,070; for example, a loosely woven scrim - of polypropylene tapes, which have been molecularly oriented and are approximately 0.10 inch wide and 1-2 mil thick, and which are substantially perpendicular to each other, with 1/4 to 1/8 inch spacing between the tapes - has been found to be effective as a general purpose reinforcement.

It is possible to provide a modified form of improved paperboard material B substantially as illustrated in Figures

2 and 2a. The reinforced improved paperboard material B also comprises a pair of spaced-apart substantially parallel outer liners 18 and 20 which are separated by and connected to an intermediate corrugated layer 22. Suitably applied such as by adhesives or other known means to the upper surface of the liner 18 is a plastic mat or substrate 24 having the reinforcing scrim 26 applied thereto. In this case, it can be observed that the plastic mat 24 is applied in such manner that the reinforcing scrim 26 is attached to the exposed surface of the liner 18. However, it should be understood that in other applications, the plastic mat 24 could be applied in such manner that the reinforcing scrim 26 was exposed.

This latter product and one method of making it has already been described in the above in connection with Figures 1 and 1a and a method of attaching the scrim to the liner. For the former where scrim 26 is overlaid by a plastic mat/film 24 the general and detail description in connection with Figures 1 and 1a with respect to the method of making product A apply here also. For example, such a product was made by first extruding a film of PE unto liner 18 and while the PE was still relatively fluid, scrim 26 and plastic mat/film 24 was laid (in that order) down onto the PE adhesive layer; this reinforced liner 18, 26, 24 together with liner 20 was attached to corrugated layer 22 using conventional techniques for manufacturing corrugated paperboard.

This form of plastic mat 24 is more fully illustrated in Figure 4 of the drawings. In this regard, it should also be observed that a similar reinforcing scrim could be applied to the undersurface of the plastic mat 24.

The various strands are usually adhesively applied to the plastic mat 24, although they may be molded therein or otherwise integrally formed with the mat 24.

Figures 3 and 3a illustrate yet another modified form

of improved corrugated paperboard material C which is constructed in accordance with and embodies the present invention. The improved paperboard material C generally comprises a pair of spaced-apart parallel outer liners 28 and 30 with an intermediate liner 32 therebetween. A corrugated layer 34 is interposed between and connected to the outer liner 28 in the intermediate liner 32 and a second corrugated layer 36 extends between and is connected to the opposite surface of the intermediate liner 32 and the outer liner 30, in the manner as illustrated in Figure 3. In this case, a reinforcing scrim 38 on a plastic mat 40 is attached to the exposed surface of the upper liner 28. In this regard, the mat containing scrim is the same as that illustrated in Figure 4 and described in connection therewith. It should also be observed that similar reinforcing scrim may be attached to the exposed surface of the outer liner 30 or otherwise, a plastic mat/film and reinforcing scrim thereon may be suitably attached to the exposed surface of this liner.

Similarly, any or all of the liners 28, 30, 32 and corrugated layers 34, 36 may have a reinforcing scrim attached to any one of their surfaces. The details of how this can be done have already been described in the above. Corrugated paperboard having two layers of corrugations is referred to in the trade as "double wall board" (that with one layer, as "single wall board"); conventional techniques for making such boards can be used to put the various scrim reinforced liners/layers together to produce the products of this invention.

Still another modified form of improved paperboard material D is illustrated in Figure 5 of the drawings and comprises a pair of outer liners 42 and 44 with an intermediate corrugated layer 46 applied to the interiorly presented surface of the liner 44. A plastic mat 50 having the

reinforcing scrim 48 applied thereto, and which is substantially identical to the mat 24 with the scrim 26 thereon, is applied to the interiorly presented surface of the liner 42 prior to the complete construction of the paperboard material. In this case, the scrim would be in engagement with the interiorly presented surface of the liner 42 and bonded thereto and the plastic mat 50 would be, in turn, bonded to the peaks of the corrugated material 46. In this connection, it should also be observed that similar reinforcing scrim or otherwise a plastic mat having reinforcing scrim thereon could be inserted between the liner 44 and the corrugated layer 46. If even further reinforcement is required, reinforcing scrim could also be applied to one or both of the exterior faces of the respective liners 42 and 44.

In addition, instead of the plastic mat/film 48 being bonded directly to the corrugated layer 46 it can be bonded to a third paperboard liner and this liner bonded to the peaks of the corrugated material 46; this embodiment would be more amenable to conventional corrugating equipment, while that shown in Figure 5 could be produced more readily by the method and apparatus described in Canadian Patent No. 879,643. The following is an example of a product using three liners: a kraft linerboard (42 lbs. per 1000 square feet) was coated with a 0.5 mil PE film; a 0.5 mil PE film was extruded unto a 40 lb. per 3000 square feet kraft paperboard and while the PE was still relatively fluid a reinforcing scrim and the previously coated 42 lb. paperboard was laid down (in that order) unto the PE layer (with the PE side of the 42 lb. board next to the scrim); This reinforced double - paper liner together with another 42 lb. kraft liner was attached to a corrugated kraft medium, with the uncoated surface of the 42 lb. layer (of the double-liner) being bonded to the peaks

of the corrugated layer, using conventional equipment.

From the foregoing embodiments, it can be observed that a large number of improved paperboard materials can be constructed in accordance with the present invention and the present invention is not specifically limited to those embodiments illustrated and described herein.

As is evident from the above one of the objects of the invention is to reinforce products which are presently on the market so as to extend their applicability. Unreinforced paperboard products, because of the nature of the material from which they are made, offer wide scope for improvement and corrugated paper products, in particular, offer many opportunities in this regard. Similarly inexpensive boards made from plastic materials in a form which is relatively weak, also offer opportunity for improvement. Boards made from foamed plastic are a good example in that respect, e.g. a foamed board/sheet made out of polystyrene, urethane, etc. There boards could be readily reinforced by attaching the above reinforcing scrim to either or both surfaces of such boards using the methods described above. For example, a 1 mil film of PE was extruded unto one surface of a one-half inch sheet of foamed polystyrene, and while the PE was relatively fluid a reinforcing scrim and a 42 lb. kraft linerboard (previously coated with an 0.5 mil PE on one side) was laid down (in that order) unto the PE layer (with the PE side of the 42 lb. liner next to the scrim). The PE-scrim-PE-paperboard layer served to add greater strength to the foamed polystyrene.

The scrim reinforced corrugated product of this invention exhibits its greatly increased strength characteristics, particularly in puncture, tear and mullen (bursting) strength) over similar conventional products and this increase in strength is generally obtained at a lower cost per unit

improvement in strength than by other conventional methods. If the PE film approach is used to adhere the scrim to the liner or medium then moisture and waterproofness is also acquired. Resistance to bulging and fatigue is also obtained from the reinforcement.

The following table compares products of the present invention (IP) with conventional products (CP) (in which there is no scrim):

Board Type	Puncture		Mullen (psi)		Tear (in. oz.)	
	CP	IP	CP	IP	CP	IP
Single Wall (200C)	210	890	230	440	-	Much over¢
" " (275C)	300	965	380	575	355	600
" " (350C)	315	950	380	510	415	"
Double Wall (275BC)	375	1065	360	465	-	"
" " (350BC)	410	1050	410	565	340	"
" " (500BC)	515	1155	-	-	490	
" " (600BC)	555	1155	-	-	-	
Tri-wall	1100	-	-	-	-	

Note - Tests one at 50% relative humidity.

It is apparent from the above table that certain strength properties of the product of the present invention are greatly superior to those of conventional products; it is to be noted that the puncture value for the scrim reinforced double wall board product is comparable to that for a conventional Tri-Wall product yet the cost of the former is much less than that for the latter.

A scrim-reinforced double-wall board product is also considerably superior in puncture strength to a quarter ($\frac{1}{4}$) inch tempered Masonite board particularly with respect to the "free-falling dart method" and was an adaption of ASTM test D1709; the dart weighed three (3) lbs. and was dropped a height of three (3) feet unto the center of an arched specimen;

the specimen was 18" wide; the height of arch 18";

Specimen	No. of drops to Puncture Specimen	No. of drops to break through Specimen
"¼" tempered Masonite	14	21
350 double-wall board	48	52

When the scrim-reinforced board of the present invention is made into end products, these products too exhibit superior properties. For example, in a rough handling-drum test a fifty (50) lb. nail box (packed with mails) made from a scrim reinforced single wall board (275 B type) took 190 falls to failure, while a nail box made from a conventional (275 B) board plus a (275 B) sleeve took 140 falls to failure.

The scrim-reinforced board of the present invention has also been found very useful in many other end products such as bulk bins, panel structures, water/moisture proof containers, etc.

It should be understood that changes and modifications can be made in the form, construction, arrangement, and combination of parts presently described and pointed out, without departing from the nature and principle of my invention. Therefore, any and all such changes which do not depart from the nature and principle of my invention are deemed to be covered by the invention which is limited only by the following claims.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A corrugated paperboard type material having improved puncture resistance having a reinforcing scrim bonded to at least one surface thereof, said reinforcing scrim comprising a plurality of rows of intersecting strands of a thermoplastic polymeric material.

2. The improved paperboard material of claim 1 further characterized in that the rows of intersecting strands comprise a plurality of first spaced-apart substantially parallel rows of strands and a plurality of second spaced apart substantially parallel rows of strands which are substantially perpendicular to said first rows of strands.

3. The corrugated paperboard material of claim 2 wherein each of said strands are substantially flat and have an ultimate elongation substantially corresponding to that of the paperboard material.

4. The improved paperboard material of claim 1, 2 or 3 further characterized in that said rows of strands are bonded directly to one surface of said paperboard material.

5. The improved paperboard material of claim 1, 2 or 3 further characterized in that said rows of strands are bonded to one surface of a thermoplastic polymeric substrate which is subsequently bonded to at least one exterior surface of the paperboard material.

6. The improved paperboard material of claim 1, 2 or 3 further characterized in that said rows of strands are bonded to a pair of exterior surfaces of the paperboard material.

7. The improved paperboard material of claim 1, 2 or 3 further characterized in that said rows of strands are bonded to one surface of a thermoplastic polymeric substrate and one such thermoplastic polymeric substrate is bonded to a pair of exterior surfaces of the paperboard material.

8. The improved paperboard material of claim 2 further characterized in that said rows of strands are bonded to a pair of exterior surfaces of a thermoplastic polymeric substrate and said substrate is applied to at least one exterior surface of the paperboard material.

9. The improved paperboard material of claim 1, 2 or 3 wherein said strands have been strengthened by orientation, said strands having a thickness of between .5 to 3 ml., a width between 0.1 to 0.2 inch, a spacing therebetween of 0.05 to 0.3 inch, and an ultimate elongation of less than 30%.

10. An improved corrugated paperboard material having high puncture resistance comprising a plurality of alternating layers of liner material and corrugated material bonded thereto, the exterior surfaces of said paperboard material being formed of a liner layer, and at least one of said exterior surfaces having a reinforcing scrim bonded thereto, said reinforcing scrim comprising a plurality of rows of spaced apart intersecting strands of a thermoplastic polymeric material, each of said strands

being substantially flat and having an ultimate elongation substantially corresponding to that of the paperboard material.

11. In a board material, the improvement wherein said board material has bonded thereto a reinforcing scrim, said reinforcing scrim comprising a plurality of rows of intersecting strands of a thermoplastic polymeric material.

12. The board material of claim 1 wherein said board comprises a board of a foamed thermoplastic material.

13. The board of claim 12 wherein said foamed thermoplastic material is selected from the group consisting of polystyrene and urethane, said reinforcing scrim being embedded in a layer of polyethylene bonded to said foamed thermoplastic board.

14. The method of reinforcing a paperboard material to form a product having improved puncture resistance comprising bonding to one flat outer surface of said material a reinforcing scrim comprised of a plurality of rows of intersecting strands of a thermoplastic polymeric material.

15. The method of claim 14 further characterized in that the rows of intersecting strands comprise a plurality of first spaced apart substantially parallel rows of strands and a plurality of second spaced apart substantially parallel rows of strands which are substantially perpendicular to said first rows of strands.

16. The method of claim 15 further characterized in that said method comprises bonding said rows of strands directly to one surface of said paperboard material.

17. The method of claim 15 further characterized in that said method comprises applying said rows of strands to one surface of a plastic substrate and thereafter applying said substrate to at least one exposed flat surface of the paperboard material.

18. The method of claim 15 further characterized in that said method comprises applying said rows of strands to both opposite exposed flat surfaces of the paperboard material.

19. The method of claim 15 further characterized in that said method comprises applying said rows of strands to one surface of a plastic substrate and thereafter applying one such plastic substrate to both opposite exposed flat surfaces of the paperboard material.

20. The method of claim 15 further characterized in that said method comprises applying said rows of strands to both flat surfaces of a plastic substrate and thereafter applying said substrate to at least one exposed flat surface of the paperboard material.

21. A method of reinforcing a board material comprising the step of bonding to one flat outer surface of said board material a reinforcing scrim comprised of a plurality of rows of intersecting strands of a thermoplastic polymeric material.

22. The method of claim 21 wherein said board is formed of a foamed thermoplastic material selected from the group consisting of polystyrene and urethane, said reinforcing scrim being embedded in a layer of polyethylene bonded to said foamed thermoplastic board.

FIG.1

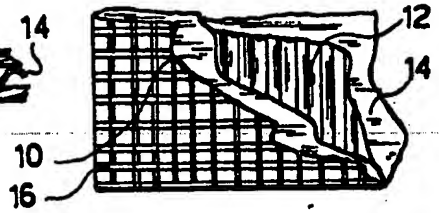

FIG.1a

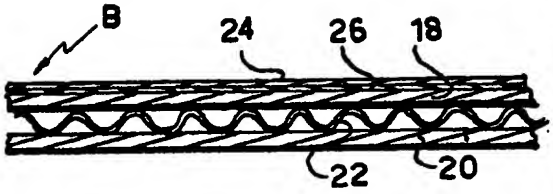

FIG.2

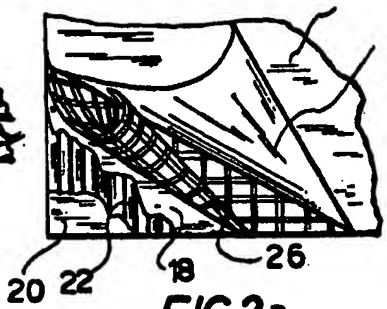

FIG.2a

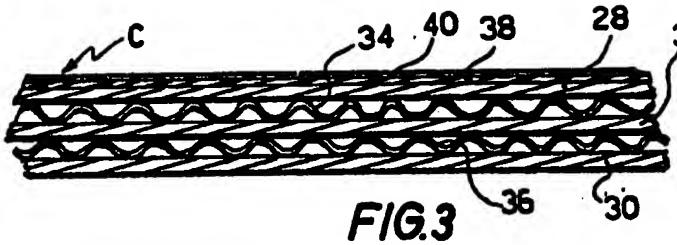

FIG.3

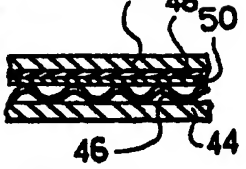

FIG.5

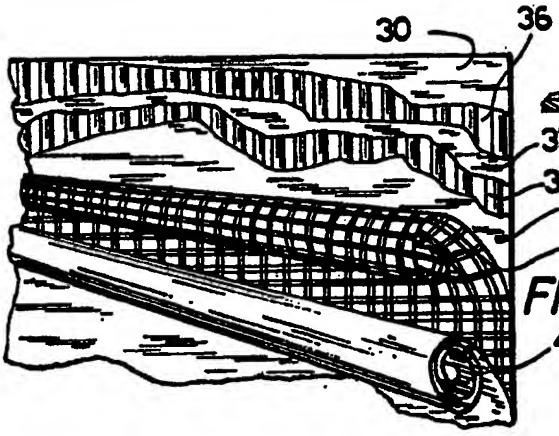

FIG.3a

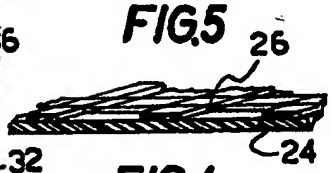

FIG.4

McFadden, Fincham & Co.
Patent Agents